AMERICAN

STATISTICAL ASSOCIATION.

NEW SERIES, No. 14. JUNE, 1891.

Presented to the AMERICAN STATISTICAL ASSOCIATION, May 15, 1891.

A BASIS FOR STATISTICS OF COST OF PRODUCTION.

BY CARROLL D. WRIGHT,

UNITED STATES COMMISSIONER OF LABOR.

One of the most difficult features of statistical work is the adoption of a basis for the collection of the information desired. Such a basis should always comprehend the full scope of the inquiry, or, as the scientific statistician would term it, the "theory," underlying the investigation; that is to say, the basis adopted should be broad enough and specific enough in its details to comprehend all that might be reasonably expected to result from a statistical inquiry on a special subject. The basis should also be considered with a view to the presentation in proper form of the facts collected. Should this latter feature be lost sight of in the preliminary work of an investigation, much difficulty would be experienced in the compilation of the original data. The official statistician who is instructed by the legislative power to collect information on a great subject must make a pretty thorough study of the possibilities of securing information and of the obstacles to be overcome in prosecuting his inquiries. Probably

no severer test of the feasibility, at least of collecting original information, has been made than that accompanying the investigation now about completed by the United States Department of Labor on the cost of production. I am not aware that any government has ever required so difficult a task at the hands of its statistical forces as that comprehended in the instructions of Congress to the Department of Labor in the act establishing the Department. This act charged the Commissioner of Labor to ascertain, at as early a date as possible, and whenever industrial changes shall make it essential, the cost of producing articles at the time dutiable in the United States in leading countries where such articles are produced, by fully specified units of production, and under a classification showing the different elements of cost or approximate cost of such articles of production, including the wages paid in such industries per day, week, month, or year, or by the piece, and the hours employed per day, and the profits of the manufacturers and producers of such articles, and the comparative cost of living and the kind of living. As I have intimated, I know of no statistical task required of an office severer than this required by Congress. There may be one exception,— when the Congress required of the Census Office the collection of facts relating to mortgage indebtedness. It will be seen by the language of the law which I have quoted that the object was to secure a comprehensive collection of information which should show the cost of producing articles in different countries, the efficiency of the labor engaged in their production, and the cost of the living of the producers, as well as the kind of their living. Of course, under such a broad designation of duties, the first difficulty that would arise would be the formulation of the proper inquiries necessary to secure the specified information. The advice of producers in various industries, experienced men and experts in their particular lines, was freely sought and as freely given, the result being a series of schedules, scientific in their nature, which would

result, if properly filled, in securing the desired information. After the fullest consideration of the instructions of Congress and consultation with manufacturers and experts in different industries and from different parts of the country, it was determined to make the investigation as broad as possible, so that the study of the cost of production in such industries as might be selected should be searching and analytical. To do this it was of course necessary that the information collected should be upon a uniform basis, so far as each industry was concerned, and, in fact, so far as the bulk of the industries investigated were concerned. It will be understood at once that but few industries could be covered under the instructions of Congress. To ascertain the cost of production, there must be a clearly defined unit of production; so, the industries selected were selected with this feature in view, consideration also being taken as to the volume of revenue which the importation of each article bore to the whole revenue of the country. The industries selected, which seemed to offer the opportunities for investigation on well defined units, were all the textile industries, glass and glassware, iron ore, iron, steel, etc. These industries, through the importation of articles manufactured in the various branches of these industries, produced, for the year ending June 30, 1889, about 47 per cent of the revenue of the country.

The investigation assumed three great features or divisions, the first relating to the cost of producing the articles selected, which, as I have said, must necessarily be articles having definite and equal units, such as a ton of bessemer pig iron, rather than a steam engine or a mowing machine; the second feature covering rates of wages, time, earnings, and the efficiency of the labor connected with the establishments furnishing the information on the cost of production; the third feature being the collection of facts covering the cost of living, total earnings, and expenditures of the men employed in the establishments called upon to furnish data relative to the cost of production, earnings, and efficiency.

The facts under the first feature were to be taken from the account books of the establishments producing the goods; for the second (wages, time, etc.) from the actual pay rolls or pay accounts of such establishments, while all facts relating to the cost of living and expenditures of men and their families were to be gathered from the men themselves. I am exceedingly happy to state that this wide and comprehensive plan, as originally adopted, has been carried out relative to the great industries named, and to an extent and with a success far beyond my expectations when it was adopted. I am free to say, however, that the results of this great inquiry, as must be the case in all other investigations, do not reach the statistical ideal of the collection and presentation of important facts; but the result can honestly be designated a "statistical triumph," in securing which many intelligent, fearless, and well informed manufacturers have been willing, for the benefit of the public, to give all the facts called for relative to their business. It is an exceedingly delicate matter to ask a manufacturer to give all the facts and figures relating to the cost of producing his goods, but manufacturers, like other people, are becoming familiar with the idea of governmental inquiry into conditions, and are more and more convinced that not only does no harm come to them from an honest statement of the facts sought, but, on the contrary, that great good may be derived from such statements. Of course, not every manufacturer who was asked to furnish the information called for by the Government accepted the invitation; but in the iron and steel, coal and coke industries the proprietors of 618 establishments in this and other countries responded and contributed facts necessary for a fairly complete report on the subject, while in the textile and glass industries the proprietors of more than 250 establishments have furnished full information covering more than 1000 separate units.

The methods adopted aided the prosecution of the investigation to a very large degree. Experts and agents were

sent directly to the producers. The difficulties met with by the American Iron and Steel Association, as testified to by the secretary of that body, as involved in making a reply to the Honorable Secretary of the Treasury as to the cost of producing iron and steel, taught the Department something, and induced it to rely upon the methods which I have always found most effective. This method may be called the "personal" method, that of sending experts and agents directly to the producer, as I have said. The experience of the Association referred to, and of all statistical bureaus engaged in the collection of industrial statistics, has for many years condemned the correspondence method of collecting facts. It has, with rare exceptions, been a failure. The personal method, that of sending well informed and well instructed agents to obtain in person what is wanted, and to fill the schedules themselves from the books of account, is the only one that will secure satisfactory results. The great merit of this latter method is that a well informed man on the spot can answer all objections and show clearly all advantages.

What I have said relates entirely to the comprehensiveness of the work delegated by Congress to the Department of Labor in respect to cost of production and the general plan of carrying out the legislative requirements. It has been difficult enough in prosecution, but the difficulties were not ended with the laying out of the plan or even with carrying it out. The great question which had to be taken into consideration, and which involved more than statistical skill or ingenuity, related to the economic features of the investigation; so the question, What is meant by cost of production? had to be answered, and in such a way as to enable the Department to present its facts. The essayist, the writer on political economy, can answer such a question without any difficulty whatever, because he has simply to arbitrarily determine what he considers cost of production, and then argue to that end. The statistician is obliged to answer the question as a practical matter. He must determine what elements

should enter into the answer; and so whatever was determined as meaning the cost of production determined the basis for statistics of cost of production. I believe I recognize and appreciate the purely economic discussion of what is meant by the term, "cost of production," and the economic sense of the term, in its various features, has been very well stated by Prof. Giddings, of Bryn Mawr College. Without adhering closely to Prof. Giddings's language, I will give his general view of the subject. The term, "cost of production," is used with at least four different meanings in economic discussions.

First. The fatigue or irksomeness of labor. All those engaged in extractive industries are fully conscious of this particular meaning of cost of production. The effort and weariness of the farmer counts with him for the cost of this or that farm operation. Prof. Cairnes insisted that in economic theory cost of production must always mean fatigue of muscle and of brain. He considered wages, interest, etc., as the rewards of production.

Second. Cost of production may mean the destruction of one objective or material utility in the production of other utilities. One manufacture destroys the products of another industry. We destroy seed, grain, fertilizers, etc., in producing agricultural crops, and we destroy coal to produce steam power. Prof. Giddings says we have to use "cost" in this sense whenever we inquire whether a nation is increasing its material means of satisfaction by the ways in which it consumes its resources. This is a very true statement. The production of iron and steel means the destruction and consumption of the great sources of ore, coal, etc.

Third. By the cost of production we may mean the sacrifice of an opportunity or of a value, or, as Prof. Giddings very forcibly illustrates it, the blacksmith might be able to make $1.50 a day as an agricultural laborer, when any other man in the neighborhood could make but $1.25; but, being able as a smith to make $2.00 a day, he stays at

his forge. He will estimate the cost of production of his work at the value of his best alternative employment,— the $1.50 a day. It is in this sense, the Professor says, we constantly use the word cost in discussions of international trade. Thus a nation that could produce iron at $11 a ton may import it at $13, simply because the labor and capital that would produce a ton of iron at $11 may be productive of enough wheat or cotton to buy a ton and a half or two tons at $13.

Fourth. Cost may mean the sum of all the prices paid for the materials and labor and sacrifices involved in production, and this is what the business man ordinarily means by cost of production,— that is, the expense of production. And it is in this sense, or in considering this sense, that the statistician must project his basis for securing and presenting the statistics of cost of production. It should be understood, to again quote Prof. Giddings,— not literally, but generally, — that cost in this latter sense is not always a *cause* of value or price; that is, the price of a product is not necessarily determined by its cost of production in the terms of the prices of labor and materials; on the contrary, the price of the final product may determine how much the producer will offer for materials and labor. The difficulties often experienced in economic discussions of determining exactly the relations of cause and effect hold good in this matter. More than one final product is commonly made from the same raw material, and the prices of those products, even after allowing for all other differences in expenses, may be very unequal. Nevertheless, the various producers will buy their raw material at substantially the same price, and that price cannot exceed the market value of the least valuable product made from the material. This is not always so in practice, but it is true theoretically. So, therefore, it is the least valuable product which largely determines the cost of production for all other products made from the same raw material, or by substantially the same kind of labor.

Recognizing these different meanings of the term, cost of production, it is evident that only a few of them, and to a certain extent, can enter into the statistical basis, and these elements of a basis must comprehend the expenses of production, the cost of production as expressed by the consumption of time, and the cost of production as expressed by the destruction of the resources furnished by nature. Not only economically speaking, but practically, these three features should enter in as the great elements of any comprehensive basis for statistics of cost of production. The other elements which I have referred to can hardly be comprehended by statistical inquiries, although all-important in any complete analysis of the cost of production.

In the investigation under review, therefore, cost of production has been stated in the three ways just enumerated, — the expense of production, the cost as determined by the consumption of time, that is of labor, and the cost as determined by the destruction of natural elements. But this is not sufficient; this is a statement of a conclusion. How shall we arrive at a basis on which to collect and present facts showing the expense of production? It is in this particular feature that all discussion would properly arise as to any determination for a basis. An examination of the elements of destruction of raw material, like iron ore, etc., is a simple affair, on which there can be no discussion; the consumption of time, or the destruction of the labor of man, is a simple matter, on which there can be no discussion by economists or business men; but when we come to what constitutes the expense of production, that is, the business view of the cost of production, there is opened a wide field for discussion, and one which will involve the integrity of any basis for the collection and presentation of statistics of cost of production.

In the report resulting from the investigation to which I have referred, and as ordered by Congress, the term cost of production has not been used in any technical or metaphysical

sense, although from the facts reported the economic cost of production, as indicated by the waste or consumption of material or of time, can be clearly ascertained. In arriving at the cost of production all expense of interest, insurance, depreciation of the value of plant, and (where existing) royalty to the owners of the soil has been excluded, as have also all charges for freight of product to place of free delivery. The facts upon these points, except the last, have been collected from such manufacturers as have seen fit to give them and have been tabulated separately, so that anyone who does not agree with the position of the Department of Labor can for himself ascertain what the cost of production would be with these excluded elements added. For the purpose of the investigation it was deemed sufficient to include only those elements of cost which are universal, positive, and absolutely essential, that is, those elements of cost that are common to all producers and which must be borne in order to bring out the completed product.

Interest can hardly be called an element of cost of production because of the variation of the amount of interest which enters into the estimates of concerns. Moreover, an establishment may have no interest money to pay, considering its plant as "sunk," or it has charged off a certain percentage each year for a sufficient number of years to wipe out the entire cost of plant, and so thereafter interest can play no part in the balance sheets or accounts of the concern. The whole amount charged off has been paid out of profits, and could not be reckoned as any part of the cost of producing a single ton. The man who pays a large interest must be content with a smaller profit. If he borrows his capital he reduces his margin of profit. The concern that has completely wiped out the cost of its plant, through a systematic and continued charging off, has the advantage, and its subsequent profits are larger. Some manufacturers in different industries charge, for instance, six per cent on the entire plant to the cost of production, dividing it over

the year's output. In such a case, if the goods are sold at this cost, the manufacturer claims that he has made no profit, when in fact he has made six per cent, and this six per cent offsets the interest he would have obtained for his capital invested in some other direction. He loses his personal services, however; or, to state it differently, he secures six per cent for the care of his capital. Most European producers of iron and steel, and all in America inquired of, have been found to consider their plant sunk to start with, and have advised the Department that the only influence which the value of plant can have upon the cost of production is through charges for repairs, and not through interest added to the positive elements of cost.

The depreciation of value of the plant, which often occupies so much of the attention of writers when speaking of the cost of production, offers a very great stumbling block in any statistical study of the cost of production. In arriving at our conclusions, which resulted in not considering this as a positive and universal element in the cost of production, we have been greatly aided not only by the manufacturers themselves, but by a work on The Depreciation of Factories and their Valuation, by Ewing Matheson, M. Inst. C. E., published in London in 1884.

It is true that the cost of repairs should be charged into the cost of production, and it is believed that the full force of the idea that depreciation should enter into the cost of production has in this way been met; that the integrity of the influence of depreciation has been preserved, and without the difficulties which would arise from an attempt to add any sum representing depreciation.

Deterioration of plant by time and use, the appraisement of the loss and its allotment in the accounts, are matters of great importance, of course, in the economy of management; but no fixed rules or rates of depreciation can be established for general use, because not only do trades and processes of manufacture differ, but numerous secondary circumstances

have to be considered in determining the proper course. The question of depreciation cannot be separated from that of maintenance, and in theory one may be said to balance the other. If this be the case, the absolute replacement of some portion of the plant every year may thus maintain an average aggregate value. In only two kinds or classes of plant, however, can such an exact balancing of loss by repairs and renewals be ventured on; one, where the plant wears out so quickly as to need replacement at short intervals, affording constant proof by the mere continuance of working that not only the earning power of the factory is maintained, but also the capital value; and in a second class that of undertakings so large and permanent as to afford a wide average of deterioration and renewal over the whole plant. In the conduct of works there is often a natural tendency to charge off for depreciation in proportion to the profits rather than to the deterioration, and where such a tendency is crystalized into action, the amount charged off being large in a year when the profits are large, the cost of production, should such amount be considered as an element in it, would be thrown out of legitimate proportion.

In the case of a very large plant, where there is considerable annual outlay for renewals as well as for repairs, such expenditure, if charged to profit, may fairly balance the average deterioration of the whole; but to secure this there should be a very ample margin, through the increase of the plant every year, for without this there would be a risk that a gradual lessening of the total value of buildings or plant would take place, ultimately involving considerable expenditure to restore its earning capacity, and this great expenditure, if added to the cost of production, would again distort the legitimate proportions thereof. In the accounts of a plant it is difficult, even for those engaged in its management, always to distinguish between the expenditure for renewals chargeable to capital and that due to deterioration; and to those outside the management it is quite impossible without

careful investigation. Actual additions to the size or capacity of a plant should be largely reckoned as increasing the fixed capital, but such an increase may be wholly or partially neutralized by deterioration. There are various methods of estimating the depreciation of a factory or plant, but it may be said in regard to any of them that the object in view is so to treat the nominal capital in the books of account that it shall always represent as nearly as possible the real value. The most effectual method of securing this would be, if it were feasible, to revalue everything at stated intervals, and to charge off whatever loss such valuations might reveal without regard to any prescribed rate. By such a plan the deterioration due to a period of constant working and of great profits, or to an average or idle year, might be properly allotted.

Such a system is adopted oftenest in factories or works where the trade and plant are of so simple or uniform a kind as to allow it without difficulty. In some manufactories there are a few chief items of plant which are more important than the rest, and whose condition and value therefore need special consideration. But, as a rule, it will be found that charging repairs to cost of production and great extensions or increase of capacity to capital serves the best economic purpose in securing the legitimate cost of production.

In the case of machinery, deterioration depends on so many circumstances, some of which relate to the machine itself, and others to the mode of using it, that it is difficult to establish a just and uniform rate of depreciation which would with integrity be chargeable to the cost of production. Sometimes a machine as a whole may continue serviceable, while important parts may become obsolete. Thus, in an iron rolling mill, new rolls may be cut to produce a certain pattern of bar iron, and if this pattern be of a standard shape and size, constantly in demand, depreciation may be based on its probable durability and the number of tons of iron which the rolls will produce before they are worn out. If, on the other hand, the pattern be peculiar in shape or size, a higher rate

of depreciation is necessary, and it may become proper to charge the whole cost of the rolls to the first out-put of bars. In this latter respect the rolls must be treated like foundry patterns, which are in some cases charged to one set of castings for which they have been specially made, and at another time as stock or standard patterns to capital. There are numerous other industries where a large proportion of the cost of manufacture is for the design and patterns, and a due depreciation in value would become of great importance.

There is a very wide divergence of practice, even in well-managed factories, as to the proper rate of depreciation for machinery. To be on the safe side a concern sometimes commences by charging off annually 10 per cent from the cost of all machinery, especially when the concern is doing a profitable business. In other cases the records of many years' working may show that 2½ per cent is sufficient. In engineering factories the rate which will probably meet the depreciation will generally be found between 5 and 10 per cent. Where the work is of a moderate kind which does not strain the machines severely, and where the hours of working do not average more than sixty per week, 5 per cent would generally suffice for machinery, cranes, and fixed plant of all kinds, excluding steam engines and boilers. Where there is a diversity of machinery and plant, as in a cotton mill, prominent cotton manufacturers, with many years' accounts to enable them to form a correct jndgment, have informed the Department that 5 per cent seems to be an appropriate rate to be added to the cost of production when this method is resorted to; but such a rate would be quite insufficient for the machinery of a rolling mill. While a rate of 7½ per cent might be supposed sufficient for the first few years, say four, the valuation at the end of that period might show that some rate between 10 and 20 per cent would be necessary to meet effectually the depreciation in value due to wear and tear, and to the fact that the machinery is likely to become old-fashioned.

Steam engines and boilers, if classed separately from the other machinery of a plant, would generally require a higher rate of depreciation, and a further separation would require that the boilers be given a rate higher than engines. The make of the boilers and engines would have much to do with the depreciation. In trades where steam engines, steam hammers, furnaces, and boilers form a large proportion of the total plant of machinery, they would have to be classed separately from the other machines, or the rate of depreciation for them should determine that for the whole; but it is often considered expedient to exclude from such a general rate of depreciation certain things, such as patterns and foundery boxes, or to class them separately. Where the depreciation is rapid, as in boilers and furnaces, the need for renewal forces itself on the attention of users, and the justice of charging expenditure on this account to profit becomes obvious, and of course to charge such to cost of production would be entirely wrong. From these considerations, and to avoid inharmonies and incongruous elements of cost, we have, to cover all contingencies and the variations of years, included repairs in the cost of production instead of undertaking to determine or accept any specified rates of depreciation by individual concerns.

The charges for insurance cannot justly be considered for statistical purposes as an element of cost of production. It is a variable and often unknown quantity. Many proprietors prefer to carry their own insurance, while others prefer to place their risks with insurance companies. This takes the cost of insurance out of the catalogue of positive and universal elements of the cost of production.

The royalties paid to the owners of the soil in the cases of coal mines, ore mines, or limestone quarries, operated by persons other than the owners, should not be included, because such charges are not positive and universal, and must of necessity correspond to the interest charge of the operator who owns his mine. In other words, the royalty paid by the

lessee represents what would be the interest on capital invested were he the owner, and is not considered as a legitimate charge against cost of production, although affecting profits or selling prices.

The charges for freight of product from the works to place of free delivery should not be included as one of the positive elements of the cost of production, because they are manifestly a part of the cost of selling the finished products, and the plans of an investigation could necessarily carry the product only to the point of finishing at the works. Moreover, such charges are variable, the products of many mills being sold free on board at mills, and of others at such a variety of points that no usable statement could by any possibility be obtained. This latter reason prevented the department from showing among the additional or theoretical charges the comparative advantages of the several establishments in respect to their proximity to market.

Notwithstanding these considerations, there are many students of economic subjects, as already intimated, who regard some one or all of these elements — interest, insurance, depreciation, and royalties — as legitimate elements in arriving at the cost of production, and for that reason a separate tabulation of such data on them as came to hand has been made. It will be found, however, on examining the short tables at the close of this article, that in nearly all cases their influence upon the cost of a unit, like a ton of pig iron or a ton of steel rails, is so slight as not to invalidate the statements made in the tables where they have been excluded.

Another disturbing element in ascertaining exact cost of production is the market price at which materials are charged. A manufacturer of pig iron may also be the producer of the ore or coke, coal, or limestone which he uses, or he may be the producer of some of these materials and a purchaser of others. If he is a purchaser, he is entitled to charge as a legitimate element of cost what he has to pay in the market for the materials, and it sometimes occurs that where a manu-

facturer produces his own ore or other materials, he considers it perfectly legitimate in making up his cost to enter what he produces at the market price he would have to pay for it provided he purchased. This statement will often account for discrepancies in the cost as charged for different materials. The influence of this is more largely felt in the production of steel rails, where the fluctuation of prices of pig iron is great, as shown by the speculation in pig iron in Great Britain. It is extremely difficult to arrive at the specific elements of cost in the production of pig iron in Great Britain on account of the constant gambling there in pig-iron warrants. This species of speculation has been carried to such a reckless extent that a measure has been introduced into Parliament for regulating dealings in pig-iron warrants. The measure aims at such speculative dealings, especially those characteristic of the Glasgow market, where it is no uncommon occurrence for operators to buy and sell enormous lines of warrants without possessing or desiring to possess a single ton of iron. Much harm has certainly at various periods been inflicted on the British iron trade as an industry by the wild gambling carried on by the iron rings, not alone through the destructive operations of bears, but also through the injudicious proceedings of sanguine bulls. The influence of this species of speculation distorts prices and, of course, costs, and it has much to do with the irregularities noticed in the quotations of steel rails. The cost of production is also affected by the freight charges on the assemblage of raw materials, like ore, coal, coke, etc. The cost of transporting ore, for instance, will vary as between two establishments located side by side and bringing their ore from the same mine. One establishment may have influence with the road by which rebates are obtained, while the other establishment, having no such influence, is obliged to pay the full official rates. While such conditions are not frequent, nevertheless, in some cases, they are disturbing elements in the attempt to arrive at exact cost of producing pig iron or steel.

In order to illustrate practically and with figures the influence of what have been designated "theoretical elements" upon the cost of a unit, I have drawn some brief tables from the report on cost of production described above. The following table shows the summary of cost of run of furnace pig iron in twenty-six establishments in the northern district of the United States, meaning by the "northern district" states embracing Pennsylvania, Ohio, and that line of states producing pig iron: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 544,377.	Average cost of one.
Ore	$3,787,982	$6.958
Cinder, scrap, etc	313,679	.576
Limestone	273,207	.502
Coke	1,810,814	3.327
Coal	201,940	.371
Total materials	6,387,622	11.734
Labor	802,283	1.474
Officials and clerks	100,607	.184
Supplies and repairs	277,413	.510
Taxes	19,615	.036
Total	7,587,540	13.938

The cost of theoretical elements, consisting of insurance, interest, and depreciation of value of plant, in some of the establishments from which the figures for the foregoing table were taken show an additional cost of $0.166 per ton, divided as follows: For insurance, $0.008; for interest, $0.122; for depreciation of value of plant, $0.036.

The following table shows the summary of cost of run of furnace pig iron in twenty-four establishments in the southern district of the United States.

A few of the establishments from which the following figures are taken show that insurance would add $0.006 per ton, interest $0.096, and depreciation of value of plant $0.066, or a total for these of $0.168 per ton. In the northern district it was $0.166.

Elements of cost.	Tons of 2240 pounds.	
	Cost of 647,728.	Average cost of one.
Ore	$2,245,830	$3.467
Cinder, scrap, etc	10,011	.015
Limestone	304,142	.470
Coke	2,889,676	4.461
Coal	800	.001
Total materials	5,450,459	8.414
Labor	987,111	1.524
Officials and clerks	105,962	.164
Supplies and repairs	397,550	.614
Taxes	25,372	.039
Total	6,966,454	10.755

Turning to the Continent of Europe, the following table, giving positive elements, shows the summary of cost of run of furnace pig iron in one typical establishment on the Continent of Europe, with the summary of cost of theoretical elements added: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 33,685.	Average cost of one.
Ore	$154,773	$4.595
Cinder, scrap, etc	67,942	2.017
Limestone	13,006	.386
Coke	97,028	2.880
Coal	238	.007
Total materials	332,987	9.885
Labor	47,620	1.414
Officials and clerks	8,225	.244
Supplies and repairs	16,428	.488
Taxes	1,321	.039
Total	*a* 406,581	*b* 12.070

SUMMARY OF COST OF THEORETICAL ELEMENTS IN THE ABOVE.

[The establishment covered by this summary reported that it had no insurance, and that there was no expenditure for interest. It gave the amount charged to depreciation, which makes the sum credited to that item below.]

Insurance	.....	.....
Interest	.....	.....
Depreciation of value of plant	$19,846	$0.589
Total	19,846	.589

a From this amount should be deducted $35,089, the value of lead, zinc, and other incidental products of manufacture.

b From this amount should be deducted $1.042, the value of lead, zinc, and other incidental products per ton of iron produced, leaving the total net cost $11.028.

Taking up another quality of iron, gray forge pig, the cost per ton of the positive elements is shown in the following summary made from eight establishments in the northern district of the United States: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 195,631.	Average cost of one.
Ore	$1,248,808	$6.384
Cinder, scrap, etc	226,402	1.157
Limestone	106,883	.546
Coke	575,759	2.943
Coal	80,419	.411
Total materials	2,238,271	11.441
Labor	257,677	1.317
Officials and clerks	29,255	.150
Supplies and repairs	110,558	.565
Taxes	5,254	.027
Total	2,641,015	13.500

The insurance for several of the establishments covered by this last table was $0.011, interest, $0.136, and depreciation of value of plant, $0.050, or a total of $0.197 per ton.

For Great Britain, on the same kind of iron, gray forge pig, the results drawn from the returns of three establishments are shown to be as follows: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 34,696.	Average cost of one.
Ore	$127,733	$3.681
Cinder, scrap, etc	1,478	.043
Limestone	12,539	.361
Coke	99,997	2.882
Coal	908	.026
Total materials	242,655	6.993
Labor	24,178	.697
Officials and clerks	1,695	.049
Supplies and repairs	9,132	.263
Taxes	994	.029
Total	278,654	8.031

None of these establishments considered depreciation of value of plant as a legitimate charge to cost of production, but from two of them it is found that the insurance would be $0.001 per ton, interest, $0.199, or a total of the theoretical elements of $0.200 per ton additional cost, were they added to the foregoing positive cost.

The following table shows the cost of positive elements of Bessemer pig iron in twenty-four establishments in the northern district of the United States: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 797,772.	Average cost of one.
Ore	$7,346,496	$9.209
Cinder, scrap, etc	83,002	.104
Limestone	345,769	.433
Coke	2,630,997	3.298
Coal	164,447	.206
Total materials	10,570,711	13.250
Labor	1,105,622	1.386
Officials and clerks	126,015	.158
Supplies and repairs	425,056	.533
Taxes	31,158	.039
Total	12,258,562	15.366

From the returns of the establishments that considered what I have designated "theoretical elements" as part of the cost, it is found that insurance adds $0.009 per ton, interest, $0.103, depreciation of value of plant, $0.110, or a total of $0.222 per ton. There is no Bessemer pig iron made in the southern states; or, at least, there was not at the time the facts herein given were collected; but for Great Britain the cost of positive elements of Bessemer pig in four representative establishments was as follows: —

Elements of Cost.	Tons of 2240 pounds.	
	Cost of 174,144.	Average cost of one.
Ore	$1,066,282	$6.123
Cinder, scrap, etc.	33,819	.194
Limestone	36,740	.211
Coke	459,081	2.636
Coal	1,914	.011
Total materials	1,597,836	9.175
Labor	116,429	.669
Officials and clerks	9,762	.056
Supplies and repairs	70,771	.406
Taxes	3,405	.020
Total	1,798,203	10.326

The theoretical elements in the Bessemer pig, as given by several of the foregoing establishments, consist entirely of interest charge, which is $0.084 per ton, neither of the establishments considering it worth while to incorporate insurance and depreciation of value of plant in the cost.

From the considerations which have been given of the difficulties surrounding the collection and classification of statistics relating to cost of production and the statistical illustrations drawn from the report in question, it will be seen that a basis for such statistics consists of two parts. First, all those elements of cost which are positive in their nature, which are absolutely essential for the production of articles, and which are universally uniform or generally uniform in their character. All the facts brought under this general designation should be considered altogether and entirely separate from what has been called theoretical elements. The second part of the basis should comprehend all those elements which are shifting in their nature, and which exist only in certain cases, and when they do exist are elements of advantage or disadvantage rather than essential elements in production.

A FORMULA FOR PREDICTING THE POPULATION OF THE UNITED STATES.

By Prof. H. S. Pritchett.

Reprinted, by permission, from *Transactions of the Academy of Science, St. Louis*, 1891.

It is often desired to represent by a mathematical equation the law connecting a series of observations for which theory gives no explanation. In such a case ignorance of the physical cause of the phenomena observed does not diminish the accuracy of the computed formula for purposes of prediction, provided the observations are accurate and there are enough of them, and provided the same causes continue to operate.

As the forces giving rise to a series of phenomena become more complicated, the equation which would represent the law connecting the phenomena would generally be correspondingly complicated. When such observed quantities result from a few general causes modified by factors varying among themselves in magnitude and direction, it may be possible to represent the observations fairly well by a comparatively simple equation.

The problem of deriving an equation to represent the law of growth of population in the United States is such a case. The factors entering into this growth, such as birth rate and death rate, immigration and emigration, etc., are more numerous and fluctuating than in older and longer-settled countries. Since, however, the only trustworthy means of predicting the population for the future consists in reasoning from the law of growth in the past, it has seemed to me an interesting question to see how nearly the data already at hand could be represented by a mathematical function.

The data available for this discussion, up to December,

1890, are contained in the ten enumerations of the census from 1790 to 1880 inclusive. The results of these enumerations are given in the following table. The population there given is exclusive of the inhabitants of Alaska and of Indians on reservations.

Year.	Population.	Year.	Population.
1790	3,929,214	1840	17,069,453
1800	5,308,483	1850	23,191,876
1810	7,239,881	1860	31,443,321
1820	9,633,822	1870	38,558,371
1830	12,866,020	1880	50,155,783

A preliminary plat showed that these values could be approximately represented by a parabola, and would be closely represented by an equation of the form: —

$$P = A + Bt + Ct^2 + Dt^3$$

where P represents the population and t the time from some assumed epoch.

Expressing the population in millions and fractions of a million, and the time (t) in decades (census years) counting from 1840, the observations furnish the following 10 equations of condition for determining the constants A, B, C and D: —

		v.
$A - 5B + 25C - 125D - 3.929 = 0$		$+ 0.078$
$A - 4B + 16C - 64D - 5.308 = 0$		$- 0.038$
$A - 3B + 9C - 27D - 7.240 = 0$		$- 0.176$
$A - 2B + 4C - 8D - 9.634 = 0$		$- 0.060$
$A - B + C - D - 12.866 = 0$		$+ 0.119$
$A - 17.069 = 0$		$+ 0.411$
$A + B + C + D - 23.192 = 0$		$+ 0.052$
$A + 2B + 4C + 8D - 31.443 = 0$		$- 0.982$
$A + 3B + 9C + 27D - 38.558 = 0$		$+ 0.758$
$A + 4B + 16C + 64D - 50.156 = 0$		$- 0.163$

Solving by the method of least squares, there result the following normal equations: —

$$\begin{aligned}
&10\,A - 5\,B + 85\,C - 125\,D - 199.395 = 0\\
-\ &5\,A + 85\,B - 125\,C + 1333\,D - 307.645 = 0\\
+\ &85\,A - 125\,B + 1333\,C - 3125\,D - 1598.197 = 0\\
-\ &125\,A + 1333\,B - 3125\,C + 25405\,D - 3409.531 = 0
\end{aligned}$$

From their solution we obtain the most probable values of A, B, C, and D as follows: —

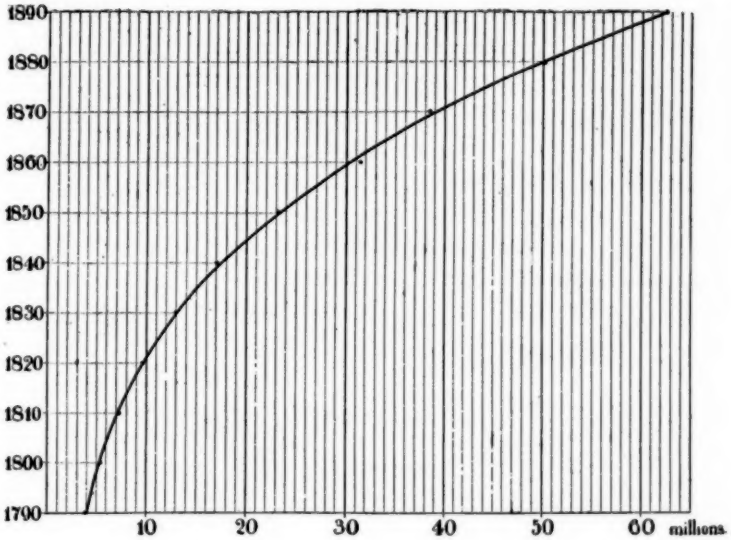
$$\begin{aligned}
A &= +\ 17.47969\\
B &= +\ 5.09880\\
C &= +\ 0.634506\\
D &= +\ 0.0307275
\end{aligned}$$

Accordingly, the population "P" for any time "t" would be represented by the equation: —

$$P = 17.47969 + 5.0988\,t + 0.634506\,t^2 + 0.0307275\,t^3 \quad . \quad . \quad .(1)$$

This equation is evidently not what might be called a normal or natural population curve. It has no asymptotes and P becomes zero for a value of t equal to about —9.4, corresponding to the year 1746. For larger negative values of t, P becomes negative. This, however, is what is to be expected from the data used, since the population there given is not the result of a slow natural growth from an original small beginning, but is largely the result of accretions from outside.

How accurately this formula represents the observed values of the population will be seen from the graphical representation of the computed curve which follows. In this plat the axis of Y is the time axis, and the abscissas represent the population expressed in millions. The observed values of the population for each decade are represented by the black dots, and the black-line curve is furnished by formula (1). With the exception of the values for 1860 and 1870, it will be noted that the curve fits the observations with great exactness.



Substituting the values of A, B, C, and D into the equations of condition, there result the residuals given in the column headed "*v*." An examination of these residuals brings out several interesting facts.

The smallness of the residuals, and the consequent close agreement of the formula with the observations, establishes the fact that the general growth of the population has been in the main a regular and orderly one.

There are two residuals which have abnormally large values. These occur in the equations furnished by the Census of 1860 and the Census of 1870. The Census of 1860 shows a population 982,000 greater than the computed value, while the Census of 1870 falls 758,000 short of the computed value. The explanation of these discrepancies is to be found in the effects of the civil war upon the growth of population. The devastating effect of the war would show itself in the Census of 1870 and succeeding years. This effect would be to give a value of the population in 1870 much below that which would be expected. This is precisely what we find to be the

case, the census enumeration in that year falling 758,000 below the computed value. An abnormally small value in 1870 would, of course, have its effect upon the population of succeeding decades, and would give an apparent difference of opposite sign to the observed population in 1860. There is, however, good reason to believe that the value of the population as determined by the census in 1870 is much smaller than the population really was at that time, and there can be little question that the computed value is much nearer the truth than the census determination at that date. The present Superintendent of the Census, Mr. Robert P. Porter, makes the following statement concerning the Census of 1870 (*Census Bulletin No. 12*, Oct. 30, 1890): —

It is well known, the fact having been demonstrated by extensive and thorough investigation, that the Census of 1870 was grossly deficient in the southern states, so much so as not only to give an exaggerated rate of increase of the population between 1870 and 1880 in these states, but to affect very materially the rate of increase in the country at large.

These omissions were not the fault nor were they within the control of the Census Office. The Census of 1870 was taken under a law which the Superintendent, General Francis A. Walker, characterized as "clumsy, antiquated, and barbarous." The Census Office had no power over its enumerators save a barren protest, and this right was even questioned in some quarters. In referring to these omissions the Superintendent of the Tenth Census said in his report in relation to the taking of the census in South Carolina: "It follows as a conclusion of the highest authority either that the Census of 1870 was grossly defective in regard to the whole of the state or some considerable parts thereof, or else that the Census of 1880 was fraudulent." Those, therefore, who believe in the accuracy and honesty of the Tenth Census — and that was thoroughly established — must accept the other alternative offered by General Walker, namely, that the Ninth Census was "grossly defective." What was true of South Carolina was also true, in greater or less degree, of all the southern states.

There is, of course, no means of ascertaining accurately the extent

of these omissions, but in all probability they amounted to not less than 1,500,000. There is but little question that the population of the United States in 1870 was at least 40,000,000, instead of 38,558,371, as stated.

The computed value just given is 39,316,000; but this is, of course, affected to a certain extent by the error in the Census of 1870, which entered into the computation of formula (1). To compute a value for 1870 which shall be derived from data unaffected by the deficit due to the war, it will be necessary to discuss the observations from 1790 to 1860 alone. The data furnish the following 8 equations of condition: —

| | | |

possible that the population in 1870 could have been less than 40,000,000, a result entirely in accordance with the conclusions arrived at by the last two Superintendents of the Census.

Had the population continued to grow after 1860 at the same rate as before, we should have had in 1890 a population of over 71 millions, about nine millions more than we really have. It is scarcely possible that the whole of this difference is chargeable to the war, but is probably due in part to a diminishing birth rate.

PROBABLE ERROR.

Assuming the formula correct, there results from the probable error of a single determination of the population ± 0.367, expressed as a fraction of a million.

This error contains, of course, both the error of the formula and the error of the census enumeration. Assuming A, B, C, and D as independent quantities, we obtain for their probable errors the following values: —

Probable error of A $= \pm 0.179$
Probable error of B $= \pm 0.127$
Probable error of C $= \pm 0.0178$
Probable error of D $= \pm 0.0066$

From these values, expressing P as a function of A, B, C, and D, its probable error may be computed at any time. This probable error would remain a small per cent of the computed population.

VALUE OF THE FORMULA FOR PREDICTION.

How closely formula (1) will continue to represent the growth of population during future decades depends, of course, upon the continuance of the same conditions of growth. A decided change in the birth rate, or rate of immigration, or a destructive war, would bring out a large discrepancy between the computed and observed values. A fair test of the formula is found by computing the population for 1890. According to the formula, we should expect in 1890 a

population of 62,677,280. The Census Bureau has within the last few weeks finished its count of the population in 1890, obtaining the result 62,622,280. The agreement between these two results is all that could be desired, the difference of 55,000 being within the limit of error of both the formula and the census count.

The general law governing the increase of population, as usually stated, is that, when not disturbed by extraneous causes, such as wars, pestilences, immigration, emigration, etc., the increase of population goes on at a constantly diminishing rate. By this it is meant that the percentage of increase from decade to decade diminishes. The law of growth expressed by equation (1) involves such a decrease in the percentage of growth.

Differentiating equation (1) we have

$$\frac{\frac{dP}{dt}}{P} = \frac{B + 2Ct + 3Dt^2}{A + Bt + Ct^2 + Dt^3}$$

which diminishes as t increases, and approaches zero as t approaches infinity. In 1790 the percentage of increase per decade was 32 per cent; in 1880, 24 per cent; in 1990 will be 13 per cent, and in 1000 years will have sunk to a little less than 3 per cent.

In order to include all available data, I have re-solved for A, B, C, and D including the data of 1890. This would yield the following 11 equations of condition: —

		v.
$A - 5B + 25C - 125D - 3.9292 = 0$		$+ 0.083$
$A - 4B + 16C - 64D - 5.3085 = 0$		$- 0.041$
$A - 3B + 9C - 27D - 7.2399 = 0$		$- 0.181$
$A - 2B + 4C - 8D - 9.6338 = 0$		$- 0.065$
$A - B + C - D - 12.8660 = 0$		$+ 0.119$
$A - 17.0695 = 0$		$+ 0.415$
$A + B + C + D - 23.1919 = 0$		$+ 0.058$
$A + 2B + 4C + 8D - 31.4433 = 0$		$- 0.975$
$A + 3B + 9C + 27D - 38.5584 = 0$		$+ 0.754$
$A + 4B + 16C + 64D - 50.1558 = 0$		$- 0.181$
$A + 5B + 25C + 125D - 62.6222 = 0$		$+ 0.012$

These yield the following normal equations: —

$$
\begin{aligned}
+\ 11.0\,A + \quad 0.0\,B + \ 110.0\,C + \quad 0.0\,D - \ 262.017 &= 0 \\
\quad 0.0\,A + \ 110.0\,B + \quad 0.0\,C + \ 1958.0\,D - \ 620.753 &= 0 \\
+\ 110.0\,A + \quad 0.0\,B + 1958.0\,C + \quad 0.0\,D - 3163.765 &= 0 \\
\quad 0.0\,A + 1958.0\,B + \quad 0.0\,C + 41030.0\,D - 11237.254 &= 0
\end{aligned}
$$

From which result the following values of A, B, C, and D: —

$$A = 17.4841 \quad B = 5.1019363 \quad C = +\,0.6335606 \quad D = +\,0.0304086$$

and the population (P) at any decade (t) after 1840 will be given by the equation,

$$P = 17.4841 + 5.1019363\,t + 0.6335606\,t^2 + 0.0304086\,t^3 \quad . \quad . \quad (3)$$

This formula, being the most probable result deducible from all the data, forms the best basis at hand for predicting the population of the future. In the course of time it is to be expected that this will depart more and more from the observed values, but for the next hundred years will doubtless represent the growth of population within a small percentage of error. Carrying forward the computation, we obtain to the nearest thousand the following values for subsequent dates: —

Year.	Computed Population.	Year.	Computed Population.
1900 . . .	77,472,000	1970 . . .	257,688,000
1910 . . .	94,673,000	1980 . . .	296,814,000
1920 . . .	114,416,000	1990 . . .	339,193,000
1930 . . .	136,887,000	2000 . . .	385,860,000
1940 . . .	162,268,000	2100 . . .	1,112,867,000
1950 . . .	190,740,000	2500 . .	11,856,302,000
1960 . . .	222,067,000	2900 . .	40,852,273,000

It would be interesting to discuss in a similar manner the population of some country like France, in which the growth has been but little affected by emigration. It is the intention of the author to do this as soon as the data are available.

It may be said of the results of the whole discussion that they confirm in a general way, and as far as they go, the accuracy of the Eleventh Census.

WEIGHT AND LONGEVITY.

T. B. MACAULAY.

Reprinted by permission from *Papers and Transactions of the Actuarial Society of America*, April, 1891.

The proper selection of lives for a life assurance company is generally considered as coming within the domain of the physician rather than of the actuary. And yet there are few questions on which the statistician cannot throw a little extra light by means of averages and probabilities based on a large number of cases. And this should be and is specially true in all matters relating to insurance, which as a business is entirely based on averages. It is only right, therefore, to expect that even the medical referee may receive valuable hints on several points from the actuarial department, and it is one of these points which I now propose to discuss briefly.

In the early years of the business in Great Britain, it was the custom of many of the companies to compel all applicants to appear personally before the board of directors. The mere certificate of the medical examiner was not considered as sufficient, and the directors wished to see the proposer himself, that they might personally form an opinion as to the risk, from his general appearance. Experience has shown that this precaution was a very desirable one. Mr. Griffith Davies reported, in 1843, that he knew of but one instance in the experience of his company (the Guardian) where the directors had accepted a life which their medical man had pronounced doubtful, but that he had on the other hand known many cases where they had rejected lives which had been reported on favorably by the medical examiner. And there was a reason for this. The average physician was formerly, and too often is now, satisfied with assuring himself that the applicant is merely free from disease. He too often loses himself in the details of the examination, and considers that, because he cannot find anything wrong with any of the organs, he should, as a matter of course, give a first-class certificate of health. The non-professional man, on the contrary, is from necessity compelled to

decide on an applicant's present state of health, by his general outward appearance. A man may be entirely free from disease and yet be by no means robust or likely to attain an average longevity. For this reason the precaution adopted by the English companies was unquestionably a very wise one for those times, although of course utterly incompatible with the requirements of an extended business. In these days a personal appearance at the head office is of course, in the vast majority of cases, entirely out of the question, and the only point now open for discussion is, How can this lack be best made up by the companies? I believe that this can be partially done by paying greater attention than is usually given to the relation between height and weight. It is true that there are a great many persons under the standard weight, to even a considerable extent, who may yet have a thoroughly robust appearance, but it is nevertheless true that as a class those who are much under the average weight for their height are proportionately lacking in vigor. The cases when this is not so are the exceptions to the rule.

The most recent discoveries in medical science add fresh importance to this question. Consumption as a disease is due to the presence of bacilli in the system. Where there are no bacilli there is no consumption, and it is claimed that the vast majority, if not all, of those who attain manhood or womanhood were free from bacilli at birth, even though they subsequently succumbed to the disease. It is now pretty generally admitted that consumption itself is but rarely inherited, being usually the result of infection. What is inherited is a peculiarity or weakness of constitution which renders the system unable to resist the influences to which it is exposed. There are immense numbers of tubercular germs floating around like those of many other diseases, and wherever they find a suitable soil they take root and grow. On a robust constitution they will usually fail to obtain a hold, but any feebleness is apt to supply the needed ground. Since the mere fact of being much under the average weight is in itself usually a proof of some such weakness of constitution, it requires no argument to show how much importance should be attached to this question by life assurance companies. And that this connection between light weight and consumption is no mere theory has been abundantly proved, as will be hereafter shown.

For the discussion of the matter it is evident that the first point to be settled is a correct standard by which applicants can be judged.

Tables of model weights, based on various theories, have been prepared. The usual supposition is that the weight and bulk of a man increase as the cube of his height, the formula being: weight in pounds $= \frac{(\text{height, in inches})^3}{2,500}$.

This is an ingenious supposition, and the results come very near to the truth, but no mere supposition is as satisfactory as a record of actual facts, if that can be obtained. An average based on the experience of a life assurance company itself is preferable to any theory, however carefully devised. Believing this, the writer some years ago compiled a table for the guidance of his own company from the figures contained in two thousand of its own accepted applications, taken in numerical order. The result is given below. For the sake of comparison there are placed beside it the corresponding figures from the theoretical table mentioned above, and also from that known as the "American Standard."

STANDARD WEIGHT.

Height.	True Standard.	Theoretical Standard.	"American Standard."
5 ft. 1 in.	125 lbs.	113 lbs.	120 lbs.
5 " 2 "	128 "	119 "	125 "
5 " 3 "	131 "	125 "	130 "
5 " 4 "	134 "	131 "	135 "
5 " 5 "	137 "	137 "	140 "
5 " 6 "	141 "	144 "	143 "
5 " 7 "	146 "	150 "	145 "
5 " 8 "	151 "	157 "	148 "
5 " 9 "	156 "	164 "	155 "
5 " 10 "	161 "	172 "	160 "
5 " 11 "	167 "	179 "	165 "
6 " 0 "	173 "	187 "	170 "

From an examination of the above it will be seen that the results obtained by the theoretical formula differ materially from the actual facts. Short men are, on the average, heavier than the theory would show; while tall men are, as a rule, lighter. This would indicate that the assumption that the increase in breadth and general development proceed in exact ratio to the increase in height is incorrect. On the other hand, the so-called "American Standard" comes very close to the mark, although it has evidently been prepared somewhat arbitrarily.

Tables prepared from the actual measurements of bodies of men will naturally be liable to any special features which may characterize the class under examination. It is, therefore, desirable that the standard to be used by a life assurance company shall be one based on that section of the population from which its business is drawn. For instance, a table prepared by Mr. Greenleaf from recruits accepted for the United States Army during the last three years gives weights which average from seven to ten pounds below those shown by applicants for life assurance. The reason is easily seen. The age of recruits is much under that of applicants for policies, and the table is, therefore, valueless for life assurance purposes. It represents the average weight of immature young men, and not of those in middle life.

The influence of age on weight is very important, as may be seen by the following analysis of the two thousand policy-holders already mentioned.

AVERAGE WEIGHT AT VARIOUS AGES.

Ages.	Weight.
16 to 20	142 lbs.
21 " 25	149 "
26 " 30	153 "
31 " 35	157 "
36 " 40	158 "
41 " 45	159 "
46 " 50	163 "
51 " 55	168 "
56 " 60	172 "

The above throws into relief several interesting features. The weight of the average healthy man is seen to increase rapidly until about age 35, to remain comparatively stationary for the next ten years, and then to advance steadily again until age 60. What course it follows after that age we have no means of tracing, as the data are too few. It will thus be seen that from 20 to 60 the weight increases on the average thirty pounds, or three-quarters of a pound per annum, although the increase is not evenly distributed. A young man may be considerably under the average for his height and yet be perfectly healthy, but the same deviation from the standard in the case of an older person would be very suspicious. Persons between 16 and 20

are usually about thirteen pounds under the average, those between 21 and 25 about six pounds under it, and those between 26 and 30 about two pounds under it; while those between 31 and 40 are slightly over it, and those of higher ages considerably above it, those between 56 and 60 being as much as seventeen pounds beyond the average.

The influence of occupation has next to be considered. The following shows the main results obtained from a re-classification of the same cases:—

AVERAGE WEIGHT OF PERSONS ENGAGED IN VARIOUS OCCUPATIONS.

Occupation.	Weight.
Tailors	145.1 lbs.
Clerks and Salesmen	147.1 "
Shoemakers and Saddlers	148.0 "
Druggists	148.1 "
Laborers	148.3 "
Manufacturers	151.1 "
Founders and Moulders	151.3 "
Teachers	151.4 "
Carpenters, Coopers, etc.	152.6 "
Machinists	153.5 "
Merchants	153.7 "
Bankers, Insurance Managers, etc.	154.2 "
Blacksmiths	155.4 "
Agents, Brokers, etc.	156.2 "
Commercial Travellers	158.1 "
Barristers, etc	160.1 "
Physicians	160.6 "
Farmers	160.9 "
Masons and Bricklayers	162.2 "
Clergymen	163.7 "
Hotel-keepers	166.7 "
Butchers	169.3 "

While examining the above it must not be forgotten that the differences shown are not in all cases due to occupation alone. The average age of persons is not the same in all occupations. For instance, bankers, barristers, and merchants are, as a rule, older than their clerks and salesmen, and are, in fact, as a class, composed chiefly of persons who have graduated from the humbler positions.

Let us now proceed to consider the influence of climate. The cases on which the standard previously mentioned is based were exclusively Canadian. The impression is very general that the average prevailing in the tropics is considerably below this. To test this point

I have had another table of averages prepared, based on applications received from the British West Indian Islands, with the following results: —

AVERAGE WEIGHT OF HEALTHY WHITES IN BRITISH WEST INDIES.

Height.	Weight.	Height.	Weight.
5 ft. 1 in.	125 lbs.	5 ft. 7 in.	144 lbs.
5 " 2 "	128 "	5 " 8 "	149 "
5 " 3 "	131 "	5 " 9 "	154 "
5 " 4 "	135 "	5 " 10 "	160 "
5 " 5 "	138 "	5 " 11 "	166 "
5 " 6 "	141 "	6 " 0 "	173 "

It will be noted that this table agrees very closely indeed with that based on Canadian lives. The average height of British West Indian whites was 5 ft. 8.4 in., and their average weight 153.2 lbs., while the corresponding figures of the Canadian applicants of British extraction were 5 ft. 8.6 in., and 155.0 lbs. The two tables, therefore, practically agree, and the conclusion would appear irresistible that the northern standard is a fair one for West Indian whites also. An examination of the question of age, however, shows that the average age of these cases exceeds that of the Canadians, and that the standard weight is not reached in the West Indies till a little later in life than in the north. It follows, therefore, that a somewhat greater laxity may be quite allowable there in the case of young lives.

The above observations on West Indian lives have been confined to the white population. A comparison with mulattoes and blacks may be interesting.

British West Indies.	Height.	Weight.
Average of white applicants, . . .	5 ft. 8.4 in.	153.2 lbs.
Average of mulatto applicants, . .	5 " 8.0 "	149.2 "
Average of black applicants, . . .	5 " 7.6 "	154.0 "

It will be seen that as regards height the mulattoes, as might be expected, occupy a middle position between the whites and blacks, but in regard to weight they are below both. The proportion of declined cases among the mulattoes (not included above) was, moreover, nearly double that among either whites or blacks. It is, perhaps, a little surprising that the weight of the blacks should be a trifle in excess of that of the whites, but it must be remembered that those blacks who are in sufficiently good circumstances to assure their lives

are apt to be over the average age, and also, perhaps, to a certain extent, picked men physically.

There are certain national characteristics worth noting.

National Characteristics.

Average of British Canadians, . . .	5 ft. 8.6 in.	155.0 lbs.
Average of French Canadians, . . .	5 " 7.3 "	149.9 "
Average of British West Indian whites,	5 " 8.4 "	153.2 "
Average of Spanish West Indian whites,	5 " 6.6 "	144.4 "

The number of female applicants was hardly sufficient to form a thoroughly reliable basis, but as far as they went they agreed almost exactly with the standard for male lives.

In the "Mortuary Experience of the Mutual Life of New York," published in 1877, by Drs. Winston, Gillette, and Marsh, the influence of light weight on mortality was dealt with at some length. They pointed out that nearly eighty per cent of those who had died of consumption in that company had been under the average weight, as indicated by the "American Standard," at the time for applying for assurance. This is certainly startling, but not necessarily conclusive, since the average age at entry of consumptive cases was probably younger than that of the whole company. But no objection can apply to those who entered between the ages of 30 and 40, since the average weight at those ages should be even a little beyond the standard, and yet it was found that of 227 consumptives who assured between those ages only forty-eight were over the average, while 179, or seventy-nine per cent, were under it. This result is certainly surprising and ominous. The conclusion drawn by the authors was summed up in the following words: "We consider it proved by our tables that a weight below the average is a very suspicious circumstance, as indicating a tendency to consumption, and would advise that all persons presenting such disproportionate figure should be most carefully scrutinized."

The most thorough and practical, and therefore the most valuable, contribution to this phase of the subject is that contained in the experience of the Washington Life Insurance Company, compiled by their actuary, the esteemed secretary of this association, Mr. Pierson, and their medical officer, Dr. J. W. Brannan. I extract a few points.

Those who died from	Average Height.	Average Weight.
All causes, ...	5 ft. 8.2 in.	156.2 lbs.
Consumption, ...	5 " 8.2 "	143.7 "
Other causes, ...	5 " 8.2 "	158.9 "

Although the height was exactly the same in all classes, the consumptive cases were, on the average, 15 lbs. under those who died from other causes.

PROPORTION OF DEATHS FROM CONSUMPTION TO TOTAL DEATHS.

Among those whose weight was	Per Cent.
Above standard,	5.47
Standard,	17.86
Below standard,	30.72
Whole company,	17.65

In the above classification the standard group included all those whose weight was within five pounds above and five pounds below the "American Standard," while the others included those above and below this class respectively.

The following table shows how great is the importance to be attached to weight in the way of either accentuating or annulling any predisposition towards consumption, either hereditary or personal: —

PROPORTION OF DEATHS FROM CONSUMPTION TO TOTAL DEATHS.

Among those who were	Persons Having Some Tubercular Taint Either in Family or Personal History.	Persons with no Taint Whatever.
Over Standard Weight	6.13 per cent.	5.28 per cent.
Standard Weight	27.27 "	15.84 "
Under Standard Weight	48.39 "	24.21 "
Total	28.35 "	14.56 "

It is thus evident that the concurrence of light weight and bad or doubtful family history must be looked upon as a matter of the greatest importance, while, on the other hand, an excess of weight may fairly be looked upon as to a certain extent counterbalancing any taint in the family history, or even in the personal record.

Following up this line of thought, I have had the experience of our own company (the Sun Life Assurance Company of Canada) worked out, with the following results: —

Total number of death claims, ... 491
Those from consumption, 126, or 25.7 per cent.

This percentage is naturally high owing to the fact that the great majority of the policy-holders are yet young men, and consumption,

of course, forms a much larger proportion of the deaths at those ages than afterwards. We have, moreover, included as consumptive cases a number of deaths which we believe to be really due to that disease, but which in other classifications might have been placed under the names recorded in the certificates, such as "chronic bronchitis," "chronic pneumonia," etc.

	Average Height.	Average Weight.
Consumptive cases, ...	5 ft. 8.6 in.	150.3 lbs.
Non-consumptive cases, . . .	5 " 8.6 "	159.6 "
(Not including "respiratory" diseases.)		

Of the 126 consumptive cases there were: —

Standard weight or above, ...	32
Below standard weight, ...	94

Just about 75 per cent (74.6) of all the consumptive cases were thus under the average weight at the time of assuring.

By arranging the cases again into three groups, one including all those whose weight is within five pounds above and five pounds below the true standard, and the two others consisting of those above and below this class, we obtain the following table: —

PROPORTION OF CONSUMPTIVE CASES TO TOTAL DEATHS.

Above standard, ...	14.9 per cent.
Standard, ...	24.1 " "
Below standard, ...	34.3 " "
Whole company, ...	25.6 " "

The next table deals with the question of family history: —

PROPORTION OF CONSUMPTIVE CASES TO TOTAL DEATHS.

Among those who were	Family History Perfect.		Family History Tainted or Doubtful.	
	Number.	Per Cent.	Number.	Per Cent.
Above standard weight	7	8.1	14	22.9
Standard	14	15.9	20	42.5
Below standard	40	29.0	31	43.7
Whole company	61	19.6	65	36.3

These figures speak eloquently as to the influence of a bad or doubtful family history. They also speak with no uncertain voice as

to the effect of light weight in intensifying the danger from any family taint, and of any excess of weight in reducing such danger. They thus confirm strongly the conclusions deduced from the records of the Washington Life, although they, on the other hand, by no means go so far as to promise any practical immunity from consumption to those who are above the average weight, as the experience of that company would seem to indicate. It will, however, be noticed that the number of cases of this kind under observation is very small in both companies, and the probability is that the truth lies between the two conclusions.

Further comment on such figures seems unnecessary. My aim has been to show that the question of weight has a most important bearing on mortality, and is deserving of the most careful attention of all life companies. If I have succeeded, my task is finished.

SOME RESULTS OF SANITARY LEGISLATION IN ENGLAND SINCE 1875.

By Gary N. Calkins, S.B.

The *Revue Scientifique* for April contains a review of an article by M. H. Monod on the results of sanitary legislation in England. This article is entitled *Les résultats des mesures sanitaires en Angleterre depuis 1875*, and advocates the extension of sanitary measures in France, where the diminution in population has lately caused much concern.

In 1875 a general law was passed in England for the protection of the public health. This was known as the Public Health Act, and from this time the death rate in England has decreased for all diseases which owe their origin and growth to defective drainage and impure water supplies. Typhoid fever is such a disease, and the diminution of 57 per cent in the death rate from this malady is undoubtedly the greatest triumph for sanitary reformers.

The cost of sanitary improvements up to 1890 was about $583,500,000, or a mean annual expense of about $42,000 000, and the immediate effect was a marked decrease in the number of deaths, as the statistics will indicate.

During the 10 years from 1866 to 1875 the average annual mortality was 22.19 per 1000 inhabitants living, as the following figures show:—

Year.	Rate.	Year.	Rate.
1866	23.4	1871	22.6
1867	21.7	1872	21.3
1868	21.8	1873	21.0
1869	22.3	1874	22.2
1870	22.9	1875	22.7

From 1838, the first year that registration was taken in a careful manner, to 1865 the average annual rate was about 22.35 per 1000 living. It is sufficiently accurate to state that, for the period 1838 to 1875, the average death rate remained about the same.

But for the 10 years of the period 1880 to 1889 the average falls to 19.08; and it is interesting to note that a curve representing the rate since 1875 does not show the great fluctuations which are characteristic of the period before that time. This is probably due to the few epidemics in the last fifteen years, that of 1878 being the most noticeable when there was a large infant mortality from diarrhœa and whooping cough. The great rise in 1849 and again in 1854 was caused largely by an epidemic of cholera. In 1863, 1864, 1865, and 1866 typhoid fever kept the death rate up to an average of 24.31 per 1000. Since 1878 the rate is almost uniformly descending, as the following figures show: —

Year.	Rate.	Year.	Rate.
1879	20.7	1885	19.0
1880	20.5	1886	19.3
1881	18.9	1887	18.8
1882	19.6	1888	17.8
1883	19.5	1889	17.9
1884	19.5	....	....

It seems justifiable to assign as the cause of this diminution in the death rate the operation of the Public Health Act and the execution of duties such as drainage, inspection of water supplies, vaccination, and others, which are becoming better and better understood.

Mr. Farr, in his *Vital Statistics*, estimates the value of human life in England to be about $770 a head. "The minimum value of the United Kingdom, men, women, and children, is £159 ($770.36) a head; that is the value inherent in them as a productive money-earning race." (W. Farr, *Vital Statistics*, p. 61.)

The economic value to England of improvements which will check certain diseases, such as typhus, is obvious, for this complaint is especially virulent to man in the adult age, that is, in the age when he is producing to the best of his ability; and, from a strictly practical standpoint, we can calculate the value of the expense to England of the vast sums which she has given out for the protection of the public health.

If we suppose, which is allowable if other things remain the same, that the mortality for each year of the period 1880 to 1889 had been the same as the average annual death rate for the period 1866 to

1875, then, comparing this average with the true rate, we find the number of lives saved has been :—*

Year.	Lives Saved.	Year.	Lives Saved.
1880	43,457	1885	87,722
1881	85,743	1886	80,546
1882	68,412	1887	95,758
1883	72,013	1888	125,680
1884	72,996	1889	124,477

The total gives a gain of 856,804 lives saved, and this, according to Mr. Farr's estimate, represents a social capital of more than $650,000,000. Thus in 10 years the country has more than regained the sum that was spent for sanitary improvements in the 15 years; and in this calculation nothing figures for maladies avoided; nothing for that which cannot be expressed by figures,—spared grief, better health, and happier life.

Mr. Noel A. Humphreys, in an article published in the *Journal of the Statistical Society*, has proved that, if the death rate should continue as low as it was from 1876 to 1880, the duration of the average life of men would be prolonged two years; that of women more than three years as compared with the English life tables; and that 70 per cent of men and 65 per cent of the women concerned would be from 20 to 60 years of age, or, in other words, that the extra life would be added to the most productive age. (Longstaff: *Studies in Statistics*, p. 226.)

The diminution of mortality is not observed in all forms of disease, and the relative importance of sanitary measures for certain diseases is shown in the following table. The mortality from zymotic diseases from 1861 to 1870 was 42.54 per 10,000 living, and this was reduced to 24.52 in the period from 1880 to 1889, thus diminishing 18.02 per 10,000 inhabitants. This diminution was distributed in the following order: —

Measles	0.02	Diarrhœa, dysentery	2.56
Diphtheria	0.33	Scarlet fever	5.92
Whooping cough	0.78	Typhoid fever	6.36
Cholera	0.91		
Small pox	1.14	Total	18.02

* I have found mistakes in the *Revue d'hygiène* in the calculation of these figures, and have therefore re-computed them from the Report of the Registrar General for 1889.

Thus, while the number of deaths from typhoid and scarlet fevers has decreased notably, measles, diphtheria, and whooping cough have apparently almost completely escaped the influence of sanitary measures.

Consumption has equally diminished in England in these last years. The mortality from this cause was, in the years 1861 to 1870, 24.89 per 10,000 living. For the period 1880 to 1889 it fell to 17.36, a difference of 7.35 per 10,000.

Let us see in just what manner England has gained by these sanitary improvements; at what period or age life has been saved, and whether the average length of life has been affected. The reports of the Registrar General furnish the necessary data.

In studying the figures for the decade 1871 to 1880 it will be seen that the death rate is unequally distributed for the period of the earlier years, but rises for the later years; for men after 35, for women after 45. This is shown by an instructive table taken from Longstaff's *Studies in Statistics*, published on the opposite page. This shows the death rates for males from all causes per 1000 living at various groups of ages. The average death rate for fifty years is printed in heavy type, as are also the figures for the decade in which the maximum death rate at each age was reached. The last row of figures indicates the rise or fall per cent of the average death rate for the last decade above or below the average for fifty years.

From this table we see that for the early periods of life the death rate has decreased. In the last decennium for example, the maximum rate for males between the ages of 5 and 10 was 9.23 per 1000 in the period 1839–48. The average for the fifty years is 7.78, and the fall from this average in the decade 1879–88 was 28.5 per cent. For the age of 10 to 15 the death rate decreased from the maximum 5.11 in the period 1849–58 to 30.8, and the fall from the average 4.34 for 50 years was 29 per cent. For the ages of 15–20 the fall was 26.3 per cent from the average 6.04. But for the ages between 35 to 45 the maximum death rate was in the decade 1869–78 13.97, and in the last decade 12.51, and the diminution from the average 13.03 for the fifty years falls only 4 per cent; while for the age 45 to 55 the average rate of the last decade exceeds the average for the five decennia by 2.6 per cent, and for the age 65 to 75 it exceeds the average by 3.7 per cent; for the age 55 to 65, 3.3 per cent. But above the age of 85 years the death rate diminishes from the average by 1.1 per cent.

DEATHS PER 1000 LIVING MALES.*

Periods.	All Ages.	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85	85-
1839-1848	23.05	71.76	**9.23**	5.06	**7.09**	**9 45**	9.80	12.65	17.83	31.43	66.89	147.5	313.1
1849-1858	23.27	72.68	8.86	**5.11**	6.87	9.10	**9.86**	12.80	18.38	31.35	65.88	146.8	306.2
1859-1868	**23.47**	**73.92**	8.07	4.50	6.28	8.55	9.75	13.22	18.90	32.62	66.40	146.3	313.4
1869-1878	23.13	69.96	7.18	3.93	5.53	7.75	9.74	**13.97**	**20.01**	**34.53**	69.29	**149.5**	**322.7**
1879-1888	20.48	60.13	5.56	3.08	4.45	5.88	7.96	12.51	19.40	33.84	**70.24**	147.7	309.5
50 Years.	*22.68*	*69.49*	*7.78*	*4.34*	*6.04*	*8.15*	*9.42*	*13.03*	*18.90*	*32.75*	*67.74*	*147.6*	*313.0*
Fall or Rise Per Cent.	—9.7	—13.5	—28.5	—29.0	—26.3	—27.9	—15.5	—4.0	+2.6	+3.3	+3.7	+0.1	—1.1

* Longstaff, *Studies in Statistics*, Page 269.

From this table we see that sanitary measures affect the death rate for persons between the ages of 1 and 25 years, and especially during the period of youth from 10 to 20 years. Economically this is a great gain, for the 28 per cent of those who might have died during this age have now tided over this period of non-production, when they were a burden on the state, into a producing age. Had they died at the age of 20 or thereabouts the country would have gained no recompense for the expense of maintaining them through the non-productive period.

Or, to put this another way.[1] In 1854 a new-born boy might hope to live 39.91 years. But his son, born in 1880, could hope for 41.35 years. Now, suppose both attain to the age of 40. In the first case 26.06 more years of life might be expected, but in the second case only 25.30. Or again, suppose 1,000,000 male children were born during the period 1838–54, then, at the age of fifty-five, 409,460 would survive; of 1,000,000 male children born during the period 1871–80, at the same age of fifty, 424,677 would survive. But, at the age of seventy-five, 148,076 would survive in the first case, while in the second there would be only 144,960. That is, the death rate during the most mature age is greater than formerly. This may be due to the fact that, with improved sanitary precautions, more feeble children live to maturity and die before attaining to old age; or, perhaps, because of the bustle of the nineteenth century, of the wear and tear upon the nervous system due to competition in densely packed cities and towns.

The effect of sanitary improvements is most noticeable upon infant mortality. If we take 858,878 as the mean annual number of births between 1871 and 1880, the difference between this and the number born in an average year of the period 1838–54 shows a gain of 1,800,047 years,[2] and this alone is a great defence of the sanitary work now going on. How this may tend to weaken the race is not for me to surmise, at all events it is too late to return to Spartan methods of maintaining the race perfect.

France, it is affirmed, is sadly in need of such sanitary improvements as have diminished the death rate in England during the last twenty years. At present her population is at a stand-still, but it should increase, and, unless it does, there is something wrong in the

[1] *Sanitary Progress.* Edinburgh Review. January, 1891.
[2] The above figures are taken from *Sanitary Progress.*

body politic, since all surrounding countries are growing rapidly in population. Whatever the cause may be for such a small number of births per year, whether moral, or physical, or political, they are all remote and obscure, but the death rate is something that can be viewed and compared, and its causes investigated. Dr. Brouardel,[1] in a recent address before the *Académie de Médecine*, called attention to the disproportionate death rate in France from small pox and typhoid fever. In Germany 110 persons are lost annually by small pox, while in France the number is no less than 14,000. Dr. Brouardel attributes this to the rigidity with which vaccination is enforced in Germany, and the laxity in France.

There are 23,000 deaths from typhoid fever per year in France, and this was shown to be largely due to water supply. Thus in Vienna, before pure water was introduced, the death rate was 200 per 100,000 inhabitants; after the introduction of good water it fell to 10.

In Angôulème pure water reduced the number of deaths from typhoid fever in the proportion of 18 to 0.063. In Amiens from 111 in 10,000 to 7. In Rennes from 43 in 10,000 to 2. Dr. Brouardel affirms that if vaccination and re-vaccination were obligatory in France, and that if towns were compelled to supply pure water, the saving of life would amount to from 25,000 to 30,000 annually, and this would make considerable difference in the population.

[1] *London Lancet*, January, 1890.

REVIEWS AND NOTICES.

LONGSTAFF'S STUDIES IN STATISTICS.

Studies in Statistics. Social, Political, and Medical. By George Blundell Longstaff, M.A., M.B., etc. London: Edward Stanford. 1891. 8vo. Pp. 455. Maps and diagrams.

In this valuable volume Dr. Longstaff has compiled many of the statistical tables of the Reports of the Registrar Generals, which, to use his own language, "form a vast reservoir, into which a ceaseless stream of facts has been flowing for more than half a century. To disturb the dust upon these shelves; to fish out facts; to group, arrange, compare, and ponder over them has long been my hobby."

The principal sources employed in the compilation of the work are the Annual Reports, Decennial Supplements, Quarterly Returns, Weekly Returns, and Annual Summaries of the Registrar General's Office of England, The United States Census of 1880, The Almanack de Gotha, The Census of France of 1881, The Statesman's Year-Book, The Report of the Government Statist of Victoria, and the Supplementary Reports of the Medical Officer of the Local Government Board of England.

The first three chapters are elementary, one being devoted to the general subject of Death Rates, in which the use of the term "rate" as employed by the vital statistician is very intelligently explained. The third chapter treats of the Birth, Death, and Marriage Rates of England and Wales for a period of fifty years.

A satisfactory reply is given to the statement of certain social philosophers that epidemics do not materially affect the general death rate. Dr. Longstaff says in reply: "I do not deny that there is *some* truth in these assertions, but any benefit to the average health standard of the community that may result from an epidemic removing weakly individuals is completely overwhelmed by the permanent injury that in too many cases results to the constitutions of those who are attacked by the epidemic, and indeed escape from death, but

recover imperfectly, and have to go through life weakened or maimed. We have, in short, to deal not only with killed but with wounded."

Several chapters are devoted to the growth of new nations, the United States taking a prominent place. In this chapter the author shows the remarkable growth of the population, at the same time lamenting the fact that we have no general system of registration in by far the greater number of the states. He states that the immigration statistics of the United States are overestimated and presents the following figures in support of his position.

EMIGRATION TO THE UNITED STATES. FIVE YEARS, 1882-86.

From.	U. S. Figures.	British and German Figures.	Excess of U. S. Figures. Per Cent.
United Kingdom.....	688,865	572,003	20.4
Germany.....	833,938	666,421	25.1

His estimate of the natural increase (by excess of births only) for the United States is about two per cent annually. The Indian, the Chinese, and the Negro questions are briefly but intelligently discussed, as are also the composition of the different nationalities represented in the population of the United States. The remaining new countries to which special chapters are devoted are Canada, South America, and Australia. Other chapters follow upon the growth of cities and upon the food supply.

In the chapter entitled "Suggestions for the Census" the following questions are discussed: —

1. How frequently should the census be taken? To this, after a thorough discussion of the question, he replies: "The Census Act of 1890 should be so framed as to establish the census upon a permanent *quinquennial* basis."

2. What questions should be asked in the schedule? The author suggests several additional points to those already contained in the schedules. The inquiry as to *sickness* does not appear to present such obstacles to the author as were frequently met in the United States Census of 1890.

3. How are the results to be tabulated? In reply to this question the author quotes the valuable experience of M. Körösi, of Buda-Pesth, and also makes several distinct suggestions with reference to future work.

The concluding chapters, which form one-half of the volume, are devoted to the discussion of the following medical topics: The decline in the English death rate; Causation of summer diarrhœa; Statistical indications of a relationship between scarlatina, erysipelas, puerperal fever, and certain other diseases; Distribution of diphtheria, phthisis, pneumonia, and bronchitis, are they epidemic diseases? Communicability of phthisis; Continued fevers in London; and Hydrophobia.

Among the prominent causes to which the decline in the death rate may be attributed, Dr. Longstaff enumerates a diminished number of deaths from fever and phthisis, and to a somewhat less degree from scarlet fever, diarrhœal diseases, small-pox, diphtheria, and measles. There has also been a marked diminution of the indefinite class entitled "all other causes." Coincidently with this decline in certain diseases there has also been an increase in the mortality from certain other diseases, notably diseases of the heart, lungs, kidneys, and from cancers. The increase is less than the decrease.

As an inference he states: "Since the falling causes of death *can* only fall to zero, but the rising causes *may* rise indefinitely, the present changes may conceivably in the course of time lead to a rise in the general death rate."

The tendency for useful working life appears to be increased, but for old age to be slowly shortened. In the chapter on summer diarrhœa the author discusses the three questions: (1) Where does it kill? (2) When does it kill? (3) Whom does it kill?

To the first inquiry he concludes that the mortality is mainly in towns (as opposed to country districts), but with some remarkable exceptions. To the second, that deaths become more numerous about June 1 (three weeks after the temperature of the air rises above 50° F.), and that a fortnight after the temperature has risen to 60° F. they begin to exceed the mean. The greatest number of deaths from this cause occurs in the first week in August,* after which the numbers fall as they rose.

To the third question he replies that this disease kills persons of every age, but young infants in by far the largest proportions.

In the chapter on the distribution of diphtheria it is shown that the mortality from this disease in England is greatest in the rural districts. Assuming that of the dense districts as 1000, the figures are as follows:

* In Massachusetts last week of July. Mean of six years observations.

Mortality from diphtheria in			dense	districts,	1000
"	"	"	medium	"	1178
"	"	"	sparse	"	1507

To this he adds: "If, therefore, it were worth while to undertake the immense labor of correcting all my calculations for differences of *age and sex constitution*, the striking contrast that I have endeavored to bring out between the liability of rural and urban populations to fatal diphtheria would be *still more marked*."

The question of the probability of the accidental and fatal incidence of phthisis upon both husband and wife is treated from a purely mathematical standpoint, the problem being to ascertain from the materials at hand how frequently such coincidences might be expected to occur as a *pure matter of chance* on the hypothesis that phthisis is *not* a communicable disease.

He concludes that, to show any substantial argument for the existence of infection, it would require a much larger collection of cases than has yet been published. The chapter on hydrophobia will be of special interest to American readers in the present epidemic years of the disease. Hydrophobia destroyed 944 persons in England and Wales in the period 1847–85. It was five times as fatal in the latter half of this period as it was in the first half. London did not suffer so severely as other parts of the Kingdom as the police order of 1885 checked the spread of the disease. It is most fatal between the ages of 5 and 15, and many more males die at all ages than females. Its geographical distribution is peculiar, Lancashire suffering most, Cheshire and Yorkshire next.

The author concludes this most excellent volume as follows: "My hope throughout has been that increased knowledge of facts, alike in matters political and matters medical, may tend to make legislative and administrative efforts more reasonable, and less empirical. Sure progress is more likely to be attained by the diligent and patient study of details than by the more showy and more attractive method of *à priori* speculation, which is but too apt to lead to rash and possibly disastrous experiments."

S. W. Abbott.

KEYNES ON STATISTICS.

The Scope and Method of Political Economy. By John Neville Keynes, M.A., London. Macmillan and Company. 1891. Pp. xiv, 359.

Although this book, as the title implies, is primarily for political economists, it includes in the closing chapter of about forty pages a discussion of statistical art and methods which will be of special interest to the statistician. The bulk of the work is devoted to a restatement of the proper methods to be employed in economic reasoning. The relative and absolute importance of induction, deduction, mathematical and symbolic formulæ, and history as applied to political economy are given careful consideration. The last chapter is devoted to "Political Economy and Statistics," and a brief enumeration of "some of the precautions requisite in the use of statistics in economic reasonings." The generous treatment here given to statistics as representing a distinct method to be used in economics is evidence of the advance which this subject of study has made in the past twenty-five years. Although Mill and Cairnes discussed the question of method in economic reasoning with thoroughness for their day, yet they gave but scant recognition to statistics as an independent aid and support.

In the first part of the chapter devoted to statistics the author enters upon the question whether statistics is a science or not. His conclusions are not favorable to the assumption put forth by many Continental, and more recently by a few English and American, authors that statistics can rank as a distinct science. Mr. Keynes fairly presents the different views upon this point, and criticises in turn the definitions of Dr. Mouat, Dr. Mayr, and Prof. Mayo-Smith. These in one way or another look upon statistics as a science. With none of these conceptions does the author agree. But while not regarding statistics as a distinct science, Mr. Keynes concludes that "it is indeed necessary to recognize a theory of statistics, dealing with what may be called the technique of the statistical method, that is to say, the conditions that statistical data must fulfill, the modes in which they are to be ascertained and collected, the manner of their arrangement and employment for purposes of reasoning, the criteria

determining the validity of arguments based upon them, and the logical character of the conclusions established by their aid." Statistics, then, is a "scientific method based on the quantitative observations of aggregates."

In the denial that statistics is an independent concrete science, Mr. Keynes, in my judgment, is entirely correct, but it is doubtful if the term "method" contains the full meaning and all the attributes which properly belong to statistics. The statistician, as such, is engaged in the collection and preparation of data admitting of enumeration, which may afterwards serve as building material for the sociologist, economist, and statesman. Statistical work bears the same relation to the social sciences that the labor of the carpenter and mason does to architecture. Prof. Mayo-Smith, as the author quotes, objects to this view because it implies that the statistician is a mere drudge. But when the overpowering superiority of social science to all other sciences is perceived, and the immense importance, both relative and absolute, of statistical labor as compared with all other methods in order to make progress in these social sciences is more clearly discerned, then there need be no fear about the intellectual position of the statistician. In my opinion, it is a mistake — and this error Mr. Keynes avoids — to give to statistics a too exalted position. We need a regiment of statisticians in every branch of political and social life, and we must not scare off possible recruits by announcing that statistics is an independent and separate science, which demands all that the mastery of a science implies. There are already sciences enough to learn; but every student may be trained in statistical methods for right and honest reasoning in his political and social relations, as he is taught hygiene for healthy living in his private or personal relations.

A special topic which Mr. Keynes considers is the function of statistics in economic inquiries. There are laws in economics which are principally indebted for their discovery to statistics, as, for example, the tendency of financial crises to recur at periodical intervals. It is impossible to enumerate the economic illustrations and problems which the author suggests as involving statistics, but it is to be hoped that teachers of political economy may dwell upon this chapter and be convinced of the importance of giving more attention to statistics.

In the note to this chapter the author briefly discusses (1) the con-

ditions of the reliability of statistical data; (2) the interpretation of simple statistics; (3) the range of statistics; and (4) the grouping of statistics. The treatment throughout, while not intended to be exhaustive, is suggestive, and is a happy omen that in the future political economy will be more closely associated to statistics.

DAVIS R. DEWEY.

UNITED STATES CENSUS BULLETINS.[1]

No. 39. March 16, 1891. *Wealth and Resources of Alaska.* By Ivan Petroff. Pp. 15.

The four principal sources of wealth of which an investigation has been made are furs, fish, minerals, and timber. The total value of products shipped from the territory since it came under American jurisdiction is estimated at $63,000,000. Fur seals is the most important, being credited with $33,000,000. Other furs were valued at $16,000,000. The canned salmon product since 1884 is estimated at $7,000,000, and the cod-fish catch since 1868 at $3,000,000. No falling off in the annual yield of any of these products is noticed with the exception of the fur seal. The total shipment of gold dust and bullion does not exceed $700,000 per annum. It appears difficult to ascertain the quantity of merchantable timber, and it is thought that the amount has been overestimated.

No. 40. March 17. *Population by Counties, North Central Division.* Pp. 9.

This division includes Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. In Nebraska only one county shows a loss.

No. 41. March 19. *Agriculture, Truck Farming.* By J. H. Hale. Pp. 12.

Truck farming in this report is distinguished from market gardening as being carried on at a greater distance from markets. The various details are summarized in the statement that more than $100,000,000 is invested, the annual products reaching a value of

[1] Continued from page 236.

$76,517,000, realized upon 534,440 acres of land. This is the first time that this industry has been made a subject of census investigation, and consequently the descriptive matter is of special interest.

No. 42. March 20. *Population by Counties, South Central and Western Divisions.* Pp. 9.

In Arkansas only one county shows a decrease since 1880.

No. 43. March 21. *Coal Product West of the Mississippi River.* By John H. Jones. Pp. 8.

Tables show the product, number of mines, disposition of product, value at mines, average price per ton, number of persons employed, and wages. The quantity of coal has increased three-fold in ten years, and the value has decreased from $1.93 per ton at the mines in 1880 to $1.52 in 1889.

No. 44. March 25. *Distribution of Population in Accordance with Mean Relative Humidity of the Atmosphere.* By Henry Gannett. Pp. 3.

No. 45. March 26. *Granite.* By William C. Day. Pp. 41.

This report shows the production of granite throughout the United States, the labor, wages, and capital concerned, uses for granite and the amount consumed for each, methods by which granite is quarried, and a directory of producers. The value of the output in 1889 was $14,464,000 as compared with $5,188,000 in 1880. The greatest percentage increase of productiveness since 1880 is found in Minnesota, New York, Delaware, and Georgia.

No. 46. March 27. *Railway Statistics of the New England States.* By Henry C. Adams. Pp. 18.

The bulletins on transportation are among the most valuable of those issued by the census department, as they not only present results but discuss methods and principles involved in the collection and treatment of statistics. From this latter point of view this bulletin in particular has great value. The statistics here presented are in the main a compilation from the records of the railway companies. For a more accurate generalization the whole country is to be divided into ten territorial groups, for each of which distinct sets of averages will be worked out. The tables show mileage, equipment, employes, business done, income and expenses for each year in the decade, 1880–89.

No. 47. March 28. *Distribution of Population by Drainage Basins.* By Henry Gannett. Pp. 5.

This shows that the proportion of the population living within the region drained to the Atlantic is steadily diminishing, while of this region the part drained to the Gulf of Mexico is relatively becoming more populous.

No. 48. April 7. *The White and Colored Population of the South. 1890.* Pp. 27.

During the past decade the white population of the South Atlantic and South Central States, and of Missouri and Kansas, all of which together contain fifteen-sixteenths of the entire colored population of the country, increased at the rate of 24.67 per cent, and the colored element at the rate of 13.90 per cent. The colored race therefore has not held its own, and it is shown that the greater increase of the white population is not due to immigration. Arkansas, Mississippi, and West Virginia are the only States which have a larger percentage of colored population in 1890 than in 1880, and in these the increase is but slight. Comparisons are made for each decade back to 1850, by which it is shown that there has been no extended northward movement of the colored race since the civil war.

This bulletin also contains the count of the Chinese in California. Since 1880 there has been a decrease in this race of 3451, or 4.59 per cent.

No. 49. April 14. *Precious and Ornamental Stones and Diamond Cutting.* By George Frederick Kunz. Pp. 8.

This is the first census inquiry on this subject. The value of the product of precious stones and ornamental stones in 1889 was $188,807. The diamond-cutting industry is confined to Massachusetts and New York. The value of the product was $1,006,716.

No. 50. April 15. *Population of Rhode Island by Minor Civil Divisions.* Pp. 3.

No. 51. April 16. *Population of Vermont by Minor Civil Divisions.* Pp. 4.

No. 52. April 17. *Urban Population in 1890. Cities Containing 8000 Inhabitants or more.* Pp. 9.

The urban population in 1890 is estimated as 29.12 per cent of the total population as compared with 22.57 per cent in 1880. In 1880 there were 286 cities with population more than 8000, and in 1890 there were 443.

No. 53. April 20. *Statistics of Education. Alaska, Arkansas, Delaware, Missouri, Iowa, Michigan, Minnesota, Mississippi, New Mexico, New York, North Dakota, Oregon, Texas, Utah, Washington, West Virginia, and forty-two Cities.* By James H. Blodgett. Pp. 34.

This is a continuation of *Bulletins Nos. 17* and *36*, and presents data for the States named on similar lines.

No. 54. April 23. *Public School Finances.* By J. K. Upton. Pp. 12.

The figures in this report are for Arkansas, California, Connecticut, Idaho, Kansas, Louisiana, New Hampshire, North Carolina, Vermont, and Washington, and are mainly from official reports of school superintendents.

No. 55. April 24. *The Relative Economy of Cable, Electric, and Animal Motive Power for Street Railways.* By Charles H. Cooley. Pp. 17.

As street railways do not have any uniform system of accounts, it is difficult to treat their finances by statistical comparisons. It is therefore stated that the statistics presented in this report cannot form a basis for final judgment. The bulletin embraces statistics of fifty lines of street railway, ten of which are operated by cables, ten by electricity, and thirty by animal power.

No. 56. April 25. *Population of Maine by Minor Civil Divisions.* Pp. 7.

No. 57. April 27. *Population of Delaware by Minor Civil Divisions.* Pp. 3.

No. 58. April 28. *Population of Connecticut by Minor Civil Divisions.* Pp. 3.

No. 59. April 29. *Commercial Floriculture.* By J. H. Hale. Pp. 11.

This is the first time that as an industry floriculture has been made a subject of census investigation. The statistics are derived from schedule and personal visits of special agents to florists' establishments. 4659 establishments are enumerated. The value of the product in 1889 was about $26,000,000.

No. 60. April 30. *Irrigation in New Mexico.* By F. H. Newell. Pp. 14.

This is the second of the bulletins on irrigation, a previous one being issued for Arizona.

No. 61. May 8. *The Production of Mica.* By L. J. Childs. Pp. 6.

Contains a brief review of the industry in 1889 and previous years. The product in 1890 was valued at $50,000, the greater part of which was credited to New Hampshire.

No. 62. May 9. *Asylums for the Insane in the United States.* By Dr. John S. Billings and W. H. Olcott. Pp. 32.

During the year 1889 there were treated in public and private establishments 97,535 insane persons as compared with 56,205 treated in 1881. This increase does not indicate an increase in the proportion of insane persons to population, but rather a great increase in the amount of asylum accommodation provided and a willingness on the part of the public to make full use of all the facilities thus provided. It is not yet possible to state the total number of insane.

No. 63. May 11. *Distribution of Population in Accordance with Latitude and Longitude.* With diagrams. By Henry Gannett. Pp. 7.

This compares the distribution of the population in 1870, 1880, and 1890.

No. 64. May 12. *Foreign, National, State, and County Indebtedness.* By J. K. Upton. Pp. 52.

This includes tables of the indebtedness of 79 foreign countries, the countries of importance neglecting to send reports being Spain, Mexico, and several of the South American States. The indebtedness of the world in 1880 and 1890 is thus compared: —

Divisions.	Debt Less Sinking Fund.		Increase.	Decrease.
	1890.	1880.		
Total.....	$26,917,096,680	$25,818,521,219	$1,098,575,461	.....
Foreign nations.....	25,636,075,840	23,481,572,185	2,154,503,655	.....
The United States.....	915,962,112	1,922,517,364	.....	$1,006,555,252
States and territories...	223,107,883	290,326,643	.....	67,218,760
Counties.....	141,950,845	124,105,027	17,845,818	.....

The nominal value in gold of the currency in which the debt was stated has been used wherever it was known. Per capita calculations are made for the second table.

No. 65. May 13. *Distribution of Population in Accordance with Topographic Features.* By Henry Gannett. Pp. 7.

This classifies the population into areas differing in the character of their surface, products, and climate. Twenty-one areas are named.

No. 66. May 14. *Floating Equipment on the Great Lakes.* By Henry C. Adams. Pp. 11.

This bulletin covers all floating equipment except fishing vessels, and is a continuation of *Bulletin No. 29.* The tables show the equipment by lakes and by ports.

No. 68. May 16. *Production of Manganese Ores.* By Joseph D. Weeks. Pp. 5.

The total production of manganese in 1889 was 23,927 long tons, with a value of $238,939.

No. 69. May 18. *Population of New Jersey by Minor Civil Divisions.* Pp. 6.

No. 70. May 22. *Statistics of Churches.* By Henry K. Carroll. Pp. 27.

This is a continuation of *Bulletin No. 18*, and presents statistics of the Cumberland Presbyterian Church, Church of Jesus Christ of Latter Day Saints (Mormons), Reformed Episcopal Church, United Fratras or Moravian Church, German Evangelical Synod of North America, German Evangelical Protestant Church of North America, and Plymouth Brethren. The tables show the number of organizations, edifices, seating capacity, halls, value of church property, and number of communicants or members.

No. 71. May 23. *Production of Bluestone.* By William C. Day. Pp. 6.

The value of the product obtained in 1889 was $1,689,000.

CONGRESS OF DEMOGRAPHY.

The following is the provisional programme of the Division in Demography of the Seventh International Congress of Hygiene and Demography, to be held at London, August 10–17.

On TUESDAY, AUGUST 11TH, after a short address by the President, a discussion will be held upon: —

"*Disease and Mortality in reference to Occupation.*"

"*The effect upon Output, of Hours and remuneration of Labor respectively.*"

On WEDNESDAY, AUGUST 12TH, a discussion will be held upon —

"*The Suitability of Tropical High Lands for European Settlement.*"

"*Predisposition of the Black and White Races, respectively, to various Infectious Diseases in its bearing on Racial Distribution.*"

"*Migration of Labor.*"

On THURSDAY, AUGUST 13TH, will be read —

"*Report by Dr. Georg v. Mayr on 'Insurance Societies of the Working Classes,' in pursuance of the resolution passed at the Vienna Congress.*"

A discussion will be held on the above report, and upon —

"*The more Systematic Collection and Utilization of Demographic Statistics.*"

On FRIDAY, AUGUST 14TH, a discussion will be held upon —

"*The Physical Condition of Children at School.*"

"*Anthropometric Facts and Inferences.*"

It is expected that many subjects, besides the above, will be brought before the Demographic Congress for consideration.

Prof. Richmond Mayo-Smith will attend as delegate of the American Statistical Association.

OLD AGE AND PAUPERISM IN ENGLAND.

The London *Economist* treats of the statistical position of pauperism in England as follows: —

At the end of last January the number of paupers per thousand of the population of England and Wales was 24.3, whereas in January, 1871, it was 47.4, the corresponding figures for London being 22.7 and 50.4, respectively. Thus pauperism has diminished by nearly one-half in the course of twenty years, and only one person in forty is now in receipt of public relief as compared with one in twenty-one in the year 1871. But we agree with Mr. Chamberlain that the

return recently issued by the Local Government Board may well abate our satisfaction. Not only does it show broadly that one-seventh of the entire population over sixty years of age is pauperized, but it also brings out the startling fact that in the case of persons over seventy-five this proportion actually rises to very nearly one-third. In other words, one person in every three of all classes attaining a ripe old age is doomed to be dependent for the means of existence on parish relief either within or without the walls of the workhouse. The following table gives a summary of the return, which seems to be the first of the kind which has been published. For the purpose of comparison we have added a column showing the numbers of the population at each of the specified ages, according to the census of 1881:—

Ages.	Indoor Paupers.	Outdoor Paupers.	Total of Paupers.	Number of Persons in England and Wales at Each of the Ages Specified in the First Column.
Over 60 years of age and under 65..	13,372	27,808	41,180	727,622
65 and under 70	15,807	46,433	62,240	502,460
70 and under 75	16,809	60,899	77,708	349,955
75 and under 80	12,384	48,495	60,879	202,322
80 years and upwards	9,752	35,108	44,860	133,898
Totals.....	68,124	218,743	286,867	1,916,257

It will be seen that the proportion of paupers to population increases continuously for each of these periods of five years after the age of sixty. Between sixty and sixty-five, when a very considerable proportion of persons are practically able-bodied, and are able to earn fair wages even in manual labor, it is about one in eighteen; between sixty-five and seventy there is a sudden drop to one in eight; between seventy and seventy-five it is one in rather more than five; between seventy-five and eighty it is one in nearly three and a half; and over eighty it is one in three. When, however, we analyze the details of the statistics of which this is the summary, we find, as might be expected, very wide differences in various parts of the kingdom. In

the whole country, as already stated, about one in seven of all persons over sixty years of age is in receipt of relief. In London the proportion is not quite one in six. In the manufacturing districts of Northern and Northwestern England it is about one in nine, but in some of the agricultural counties it is as much as one in five. Of course, it has to be remembered that only about a quarter of the persons thus in receipt of relief are in workhouses, and that the rest are outdoor paupers in receipt of allowances which, in many cases, are supplemented by other sources of income.

MORTALITY OF ENGLISH CLERGYMEN.

The following is taken from the *Insurance Post:* —

A report on the mortality experience of the "Clergy Mutual" from 1829 to 1887, compiled by Mr. Frank B. Wyatt, the able actuary of the office, has recently been published. The results of Mr. Wyatt's investigations confirm in a remarkable degree the indications we already possess as to the extremely light mortality prevailing amongst the clergy as compared with the general population. This was shown in the tables published in 1864 by the Rev. J. Hodgson (the founder of this society) from his observations on the lives of the clergy, the "expectation of life" or "mean after life-time" of this class being at age 25 nearly 5 years longer than is given by the "English Life Table, No. 3, Males," at age 40, 3 years longer, and at age 55 over a year and a half longer. These observations were made on the lives of clergymen "unselected" as to medical examination. The present tables being derived from assured lives of clergymen may more fairly be compared with the Institute Hm. Tables, also derived from assured lives; and here again the superiority of the clergy lives is very apparent, the "expectations," according to the society's experience, being at age 25 more than 5½ years longer than by the Hm.; at 40 near 4 years longer, and at 55 more than 2 years longer.

The tables are numerous, and show the results of investigations into the mortality amongst the three classes of lives of which the society's *clientèle* consists,— viz., clergy, lay, and female. Of these the numbers entering were, respectively, 7050, 1800, and 520. The

results are also combined so as to form the general experience. The numbers in the two latter classes are too small to afford reliable data, but so far as they go the figures derived from them support the previous conclusions as to the greater vitality of the clerical lives. Whenever a fresh investigation shall be made into the mortality of assured lives generally, there will be a much larger basis from which to ascertain the value of female assured life than when the Hf. tables were published by the Institute of Actuaries, as, owing to the married women's property act and the great increase in the number of occupations for women, the proportion of female assurants is, we believe, considerably greater now in all offices than it was twenty or twenty-five years ago.

Mr. Wyatt has also given a table of the experience as to "unhealthy lives,"— *i. e.*, those on which an extra premium was charged on account of some defect in personal health or family history. The numbers observed upon were 355, and the deaths 71, against 61, the number expected according to the general experience. The "rating-up" appears to be justified by the result, but here again the numbers are scarcely large enough for practical conclusions to be drawn.

Dr. Stone's analysis of the causes of death amongst the assured is interesting. . . . . It is somewhat startling to find so many deaths from violence among a body of men living such peaceful lives as the clergy enjoy, twenty-nine having met their death by accident, ten by drowning, two murdered, and no fewer than seventeen by suicide. The latter appears a very heavy record; the others may, perhaps, be partly accounted for by the supposition that the society numbers many missionaries, naval chaplains, etc., on its books. As a set-off to this chapter of horrors it may be noted that "a very large percentage of the assured have hitherto died from what is approximately a natural sequence of old age."— *Insurance Post, Eng., March 21.*

FIRE STATISTICS.

At the twenty-fifth annual meeting of the National Board of Underwriters, held in New York, May, 1891, the following report of the Committee on Statistics was adopted: —

We see no reason why all the patrol organizations which the

underwriters support should not be instructed to adopt a uniform blank approved by this association, and we believe that if the information desired is confined within reasonable limits, it would be possible to induce the different fire departments to give the same details in their reports. If necessary for the fire departments to obtain authority from the legislature to ascertain the details herein mentioned, it would, we think, be readily granted on its importance being properly shown; but we believe the desired information could be had without extra legislation with the aid of the insurance companies alone, by their insisting that the values as well as the loss shall always be declared in the proofs. The cases where that information could not be reliably ascertained would be remarkably few. In all cases of suspicious losses, the fire marshal of New York already has full authority to demand such information, and in the few cases where there is no insurance on the property at all there would be so little object in withholding the information from the fire department, as to the value of the property exposed and the amount lost, that with a little persistence it could be readily ascertained.

Your committee therefore recommend the preparation of a blank which shall indicate the information to be sought from every protective organization, and also suggest the importance of soliciting the co-operation of as many fire departments as it is possible to interest in this subject.

To the members of this association and companies outside of it we would earnestly recommend, both for the assistance it would be to the object here sought, and for its own intrinsic value, the addition of a column in every loss book, showing parallel with the percentage of insurance loss the percentage of actual loss to the property involved.

The practical failure of our efforts to obtain statistics regarding a few classified hazards was reported in 1888 (and confirmed in 1889), and our efforts in that direction have therefore not been renewed this year.